CAHFSE Annual Report*

July 1, 2003 – June 30, 2004

The Collaboration in Animal Health and Food Safety Epidemiology (CAHFSE) is a joint effort among three agencies of the United States Department of Agriculture: the Animal and Plant Health Inspection Service (APHIS), the Agricultural Research Service (ARS), and the Food Safety and Inspection Service (FSIS). The mission of this important surveillance effort is: (1) to enhance overall understanding of bacteria that pose a food-safety risk by monitoring these bacteria on-farm and in-plant over time, and (2) to provide a means to routinely monitor critical diseases in food-animal production. A particular emphasis of CAHFSE is to address issues related to bacteria that are resistant to antimicrobials. Swine is the first commodity studied as part of the CAHFSE program. Swine herds that meet certain criteria (geographic location and production style) are solicited to participate in the program for a 2-year period. Herds are visited quarterly for data and sample collection.

Reporting Units

A total of 39 sites were visited in 4 States during the period from July 1, 2003, through June 30, 2004 (Table 1). Not all sites were sampled for all 4 quarters since the 39 sites were enrolled in the project at various times during the year and because enrolled sites may not have had market hogs eligible for fecal sampling at every quarterly visit. For example, four sites in Iowa were visited all four quarters while in Texas the four sites that were enrolled were visited in three quarters. The market hog inventory present is the average market hog inventory from the sites where fecal samples were collected on at least one visit during the year.

Table 1. Structure of the coverage population

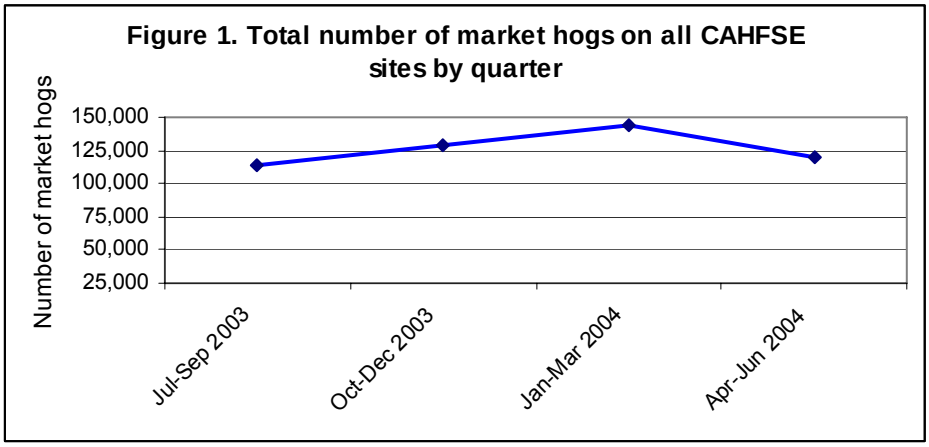
		Number of sites where fecal samples were collected for:				
State	Market hog inventory*	One quarter	Two quarters	Three quarters	Four quarters	One or more quarters
IA	29,610	3	3	2	4	12
MN	24,172	5	0	4	2	11
NC	85,758	1	4	5	2	12
TX	1,234	0	0	4	0	4
Total	140,774	9	7	15	8	39

* Averaged over all quarterly visits

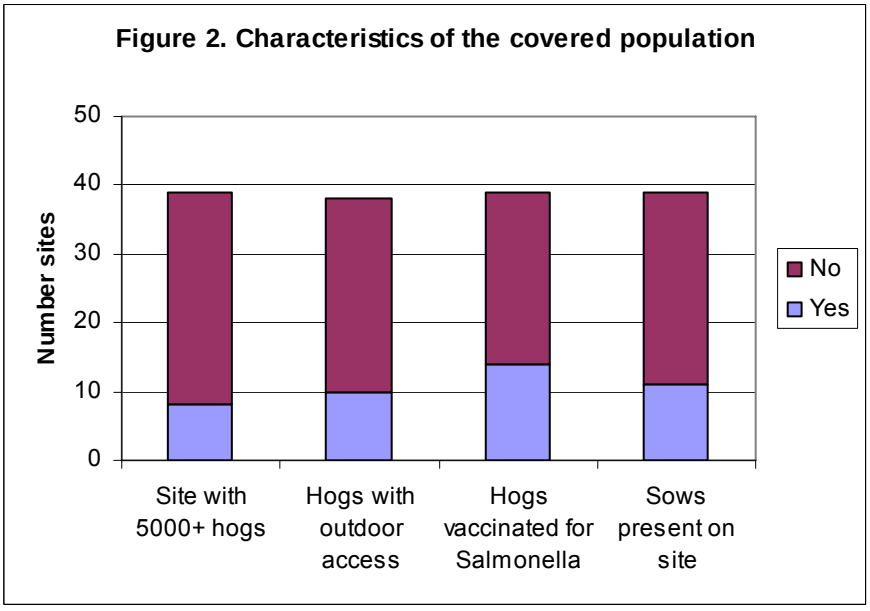
The aggregate number of market hogs on all CAHFSE sites for each quarter is shown in Figure 1. These inventory numbers are smaller than those shown in Table 1 because the missing visits influence the calculation of the total. The average market inventory in Table 1 does not account for missing site visits. The rise in this graph reflects the start-

* This report contains general descriptive results from data and samples collected from July 1, 2003, through June 30, 2004. Estimates of variability are not provided with the data at this time. A more extensive report on the analysis of these data will be provided at a later date and will include estimates of variability to facilitate comparisons among subgroups of the sample population. In the meantime caution is advised in making inference from these results.

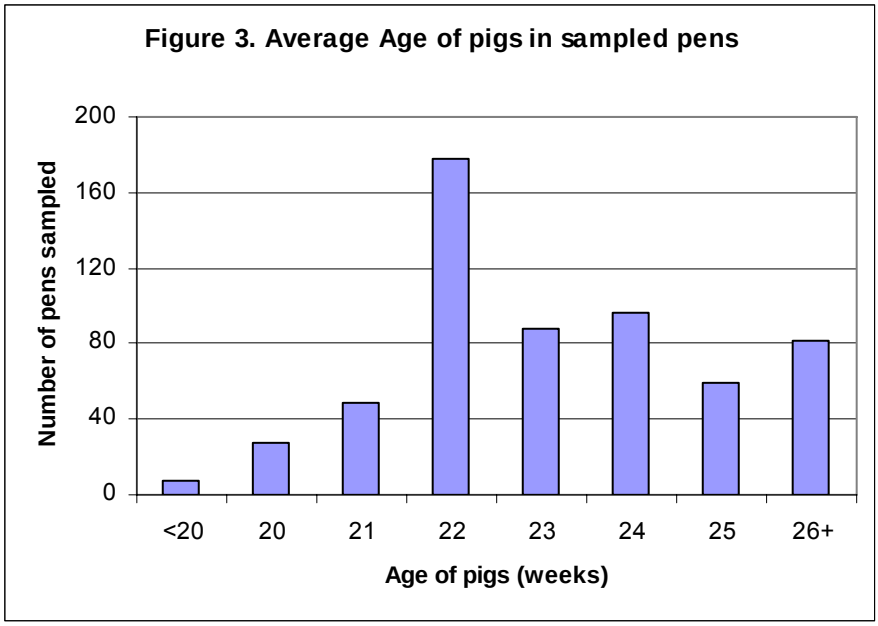
up of the CAHFSE swine project and the decline represents the difficulties completing visits during the summer quarter.



To represent the diversity of swine production facilities, some farrow-to-finish sites were enrolled in CAHFSE as well as sites that had only weaned market hogs. Some indoor-only sites were enrolled as were some sites at which hogs had outdoor access. It was expected that various size sites would be enrolled. Approximately 20 percent (8 out of 39 sites) of the operations had 5,000 or more hogs on site (Figure 2). One-third of the 39 sites vaccinated hogs for salmonellosis. A similar number of sites allowed hogs access to the outside and had sows present on the site.



The majority of hogs in sampled pens were 22 weeks of age or older (Figure 3). This reflects the goal of CAHFSE to collect fecal samples from pens of hogs nearing the end of the finishing phase. Only 14.3 percent of the pens sampled had pigs that were less than 22 weeks of age.



Recovery of enteric organisms—Salmonella

Overall, 39 sites provided samples from 587 pens to be tested for *Salmonella* and 3,654 samples were tested (Table 2). Of the 39 sites that were sampled, 26 (66.7 percent) were positive for *Salmonella* (Table 3). A small percentage of pens (26.4 percent) and samples (10.2 percent) were positive.

Table 2. Number of fecal samples collected and tested for *Salmonella*, by *State*

	Sites	Pens	Samples	
State	Number sampled	Number* sampled	Number collected	Number tested
IA	12	151	1,043	1,037
MN	11	151	960	958
NC	12	235	1,260	1,260
TX	4	50	400	399
Total	39	587	3,663	3,654

*The number of pens is likely an overestimate because pens identified by numbers were assumed to be different in different quarters, i.e., pen #1 qtr 1 ≠ pen #1 qtr 2.

Table 3. Number of fecal samples collected and *Salmonella* prevalence, by *type of site*

	Sites		Pens		Samples		
Sows present on site	Number sampled	Number (%) positive for *Salmonella*	Number sampled	Number (%) positive for *Salmonella*	Number collected	Number tested	Number (%) positive for *Salmonella*
No	28	17 (60.7%)	457	138 (30.2%)	2,560	2,557	350 (13.7%)
Yes	11	9 (81.8%)	130	17 (13.1%)	1,103	1,097	21 (1.9%)
Total	39	26 (66.7%)	587	155 (26.4%)	3,663	3,654	371 (10.2%)

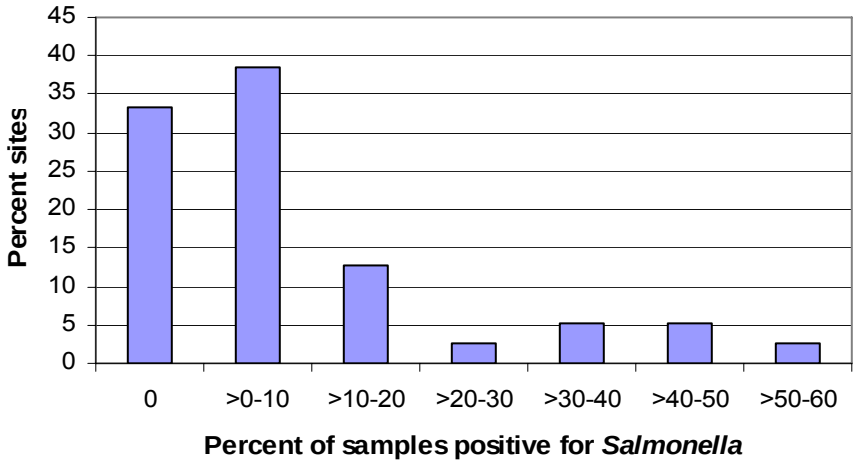
Table 4. Number of fecal samples collected and *Salmonella* prevalence, by *type of facility*

	Sites		Pens		Samples		
Hogs with outdoor access	Number sampled*	Number (%) positive for Salmonella	Number sampled*	Number (%) positive for Salmonella	Number collected	Number tested	Number (%) positive for Salmonella
No	28	20 (71.4%)	479	141 (29.4%)	2,588	2,586	354 (13.7%)
Yes	10	6 (60.0%)	100	14 (14.0%)	1,035	1,028	17 (1.7%)
Total	38	26 (68.4%)	579	155 (26.8%)	3,623	3,614	371 (10.3%)

*One site had no annual facility questionnaire.

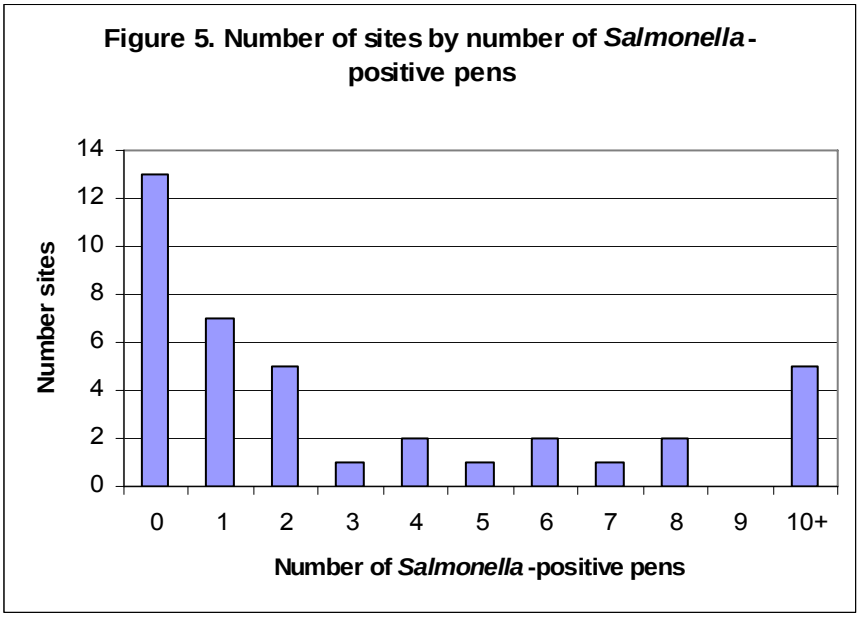
The percentage of samples that were positive for *Salmonella* for each site was between 0 and 54.2 percent. On almost 40 percent of the sites, only 1 to 10 percent of samples were positive for *Salmonella* (Figure 4). About 15 percent of sites had more than 20 percent of samples positive.

Figure 4. Percent of sites by percent of *Salmonella*-positive samples



Of the 26 *Salmonella*-positive sites, 14 were positive on 2 or more quarterly visits. Of the 39 sites sampled during the year, 30 were sampled for 2 or more quarters.

Most of the positive sites had a small number of positive pens; however, 5 sites had 10 or more positive pens (Figure 5).

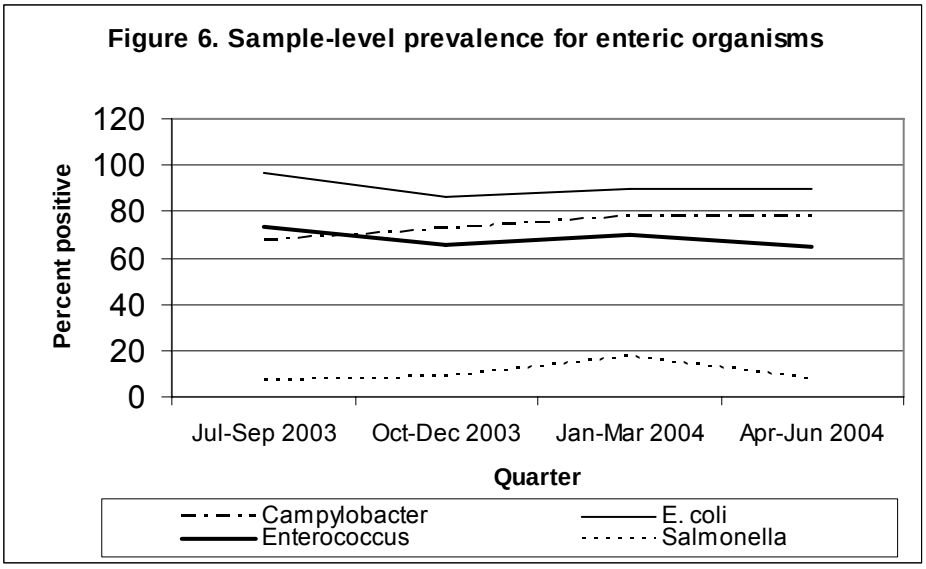


The recovery rate for the other enteric organisms was much higher than for *Salmonella* (Table 5). Approximately 40 percent of fecal samples were cultured for enteric organisms other than *Salmonella.* The recovery rate for the four enteric organisms by quarter was fairly stable (Figure 6).

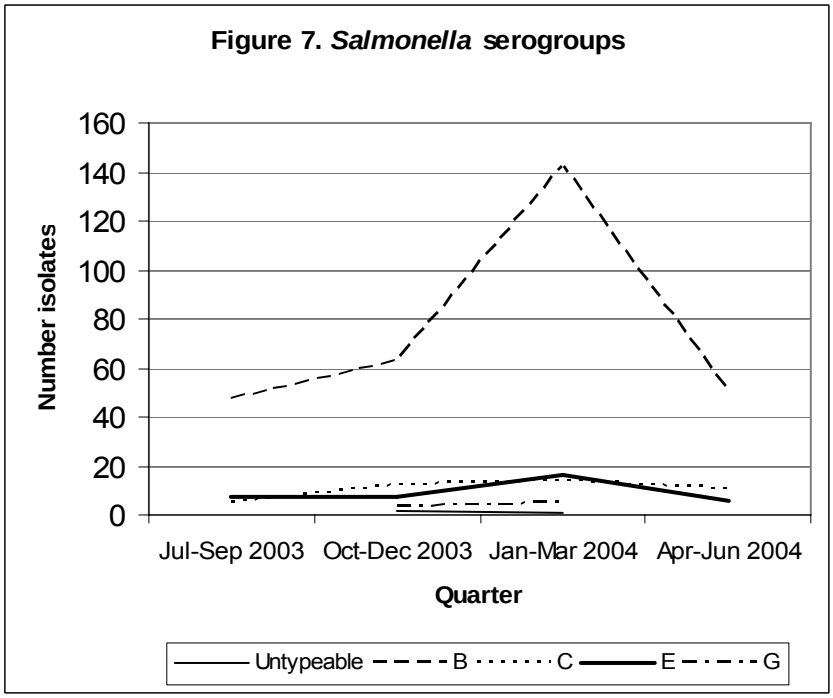
Table 5. Summary of isolation of enteric organisms

Organism	Number tested	Number positive samples	Percent samples positive	Number of samples with multiple isolates	Number isolates
Salmonella	3,654	371	10.2	19	392*
Campylobacter	1,472	1,088	73.9	N/A	1,088
E. coli	1,472	1,334	90.6	N/A	1,334
Enterococcus	1,472	1,008	68.5	1	1,009

* Two samples had 3 isolates



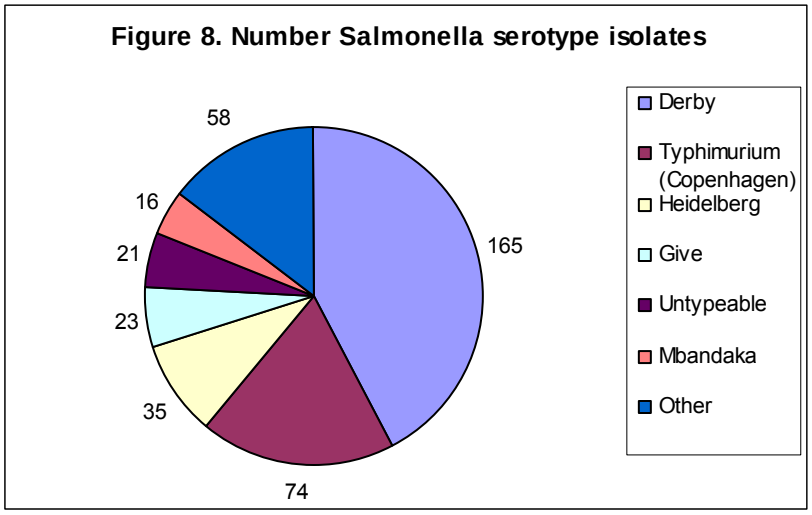
The majority of *Salmonella* isolates were from serogroup B (Figure 7). Isolates from serogroup G and those untypeable were isolated only during two quarters.



Over 60 percent (239/392) of the *Salmonella* isolates were either serotype Derby or Typhimurium (var. Copenhagen) (Table 6, Figure 8). There were 18 different *Salmonella* serotypes isolated (not including untypeable). Multiple isolates were found in some samples which accounts for the 392 isolates from the 371 positive samples.

Table 6. Frequency of *Salmonella* serotypes cultured

Salmonella serotype	Number isolates	Number pens	Number sites
Derby	165	73	16
Typhimurium (Copenhagen)	74	35	8
Heidelberg	35	20	4
Give	23	14	3
Untypeable	21	16	9
Mbandaka	16	13	7
Bovis-morbificans	10	5	3
Typhimurium	10	4	4
Anatum	8	4	3
Worthington	7	7	3
Manhattan	6	3	1
Senftenberg	4	3	2
Infantis	3	1	1
Montevideo	3	2	1
Agona	2	2	2
Reading	2	2	1
Havana	1	1	1
Kentucky	1	1	1
Muenchen	1	1	1
Total	392		



Antimicrobial resistance—Salmonella

Table 7 shows the percent of all *Salmonella* isolates that were resistant to each of the antimicrobial drugs on the panel in descending order of resistance. For the purpose of this analysis, isolates that were classified as intermediate were considered susceptible. Almost all isolates (92.9 percent) were resistant to tetracycline. For all other antimicrobials, the majority of isolates were not resistant. None of the isolates was resistant to amikacin, ciprofloxacin, or nalidixic acid.

Table 7. Number and percent of *Salmonella* isolates resistant to each antimicrobial tested

Antimicrobial	Number isolates resistant	Percent isolates resistant
Tetracycline	364	92.9
Streptomycin	177	45.2
Sulfamethoxazole	146	37.2
Ampicillin	120	30.6
Kanamycin	55	14.0
Choramphenicol	53	13.5
Cephalothin	33	8.4
Amoxicillin/clavulanic acid	32	8.2
Cefoxitin	31	7.9
Ceftiofur	31	7.9
Trimethoprim/sulfa	19	4.8
Gentamicin	18	4.6
Ceftriaxone	2	0.5
Amikacin	0	0.0
Ciprofloxacin	0	0.0
Nalidixic acid	0	0.0

Total number of isolates was 392.

Tetracycline alone was the most common resistance pattern found in the isolates (38.4 percent, Table 8). Additionally, tetracycline resistance was found in all 10 of the most common antimicrobial resistance patterns. The next most common resistance pattern was the combination of streptomycin, sulfamethoxazole, and tetracycline. The Strep/Sulfa/Tet combination occurred in the resistance pattern for 93 isolates. Of the 55 *Salmonella* isolates resistant to kanamycin, 87.3 percent had the Kan/Strep/Tet combination in their resistance patterns. All 53 *Salmonella* isolates resistant to chloramphenicol were also resistant to tetracycline and over 80 percent of them were also resistant to sulfamethoxazole.

Table 8. Top 10 antimicrobial resistance patterns

Antimicrobial resistance pattern	Number of isolates resistant	Percent of resistant isolates (n=372)*
Tet	143	38.4
Strep/Sulfa/Tet	46	12.4
Kan/Strep/Tet	23	6.2
Amp/Chlor/Strep/Sulfa/Tet	20	5.4
Amp/Strep/Sulfa/Tet	19	5.1
Amp/Chlor/Sulfa/Tet	13	3.5
Amox/Amp/Cefox/Cefti/Ceph/Kan/Strep/Tet	11	3.0
Sulfa/Tet	10	2.7
Strep/Tet	9	2.4
Amp/Kan/Strep/Sulfa/Tet	8	2.2

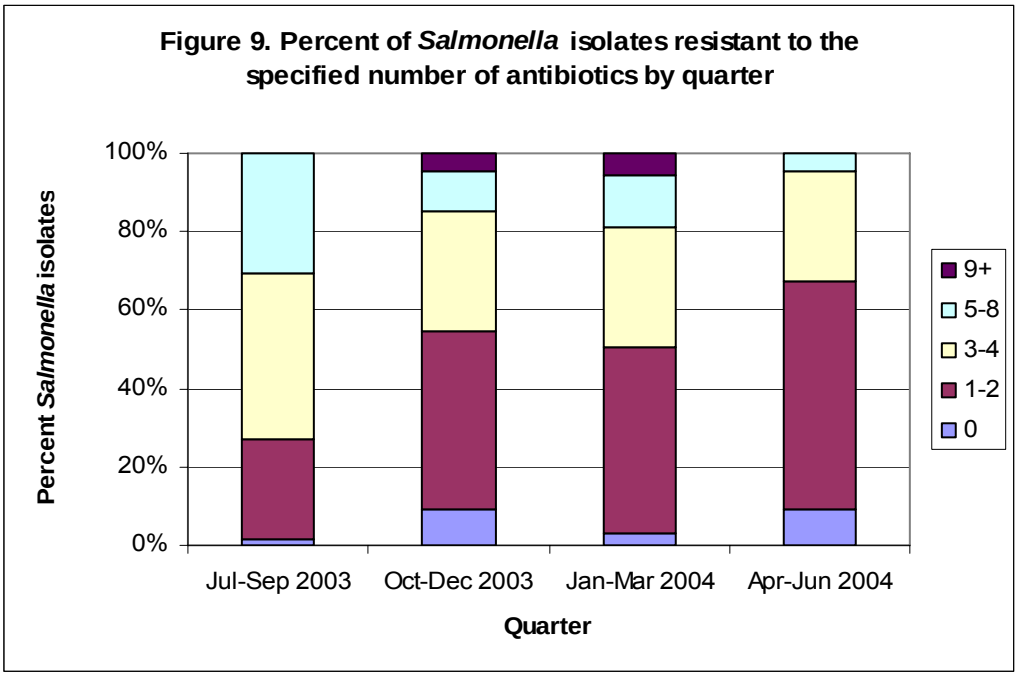
*20 of the 392 isolates were susceptible to all antimicrobials tested.

Table 9 shows the top five antimicrobial resistance patterns in descending order by *Salmonella* serotype for Derby, Typhimurium (var. Copenhagen), and Heidelberg. Forty-one percent of Derby isolates were multiresistant compared to 85 percent of Typhimurium (var. Copenhagen) and 100 percent of Heidelberg isolates. Note: Table 9 only includes the 3-5 most common resistance patterns.

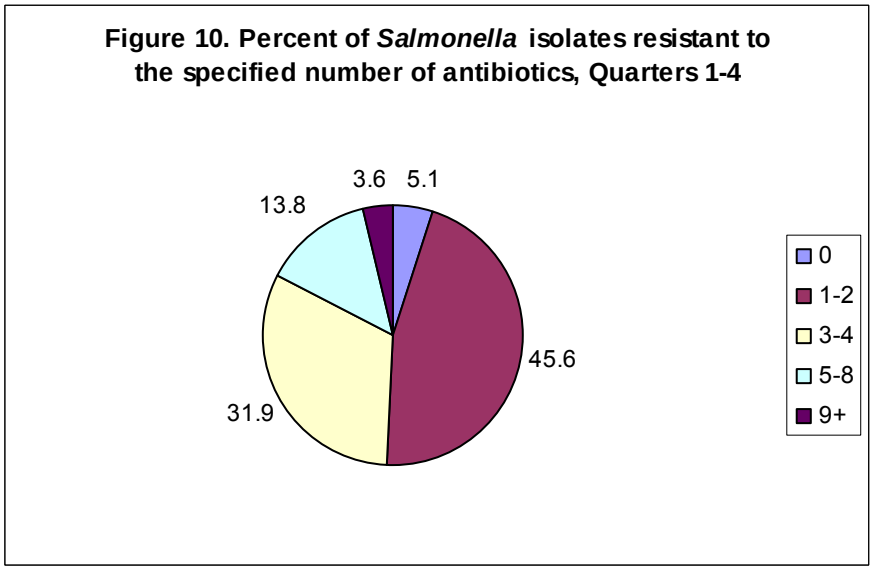
Table 9. Five most common antimicrobial resistance patterns for top three *Salmonella* serotypes

Salmonella serotype	Number of isolates	Number of antibiotics for which there was resistance	Resistance pattern
Derby	5	0	
	91	1	Tet
	39	3	Strep/Sulfa/Tet
	8	2	Strep/Tet
	3	9	Amox/Amp/Cefox/Cefti/Ceph/ Chlor/Gent/Strep/Tet
	3	2	Kan/Tet
Typhimurium (Copenhagen)	2	0	
	20	5	Amp/Chlor/Strep/Sulfa/Tet
	16	4	Amp/Strep/Sulfa/Tet
	12	4	Amp/Chlor/Sulfa/Tet
	5	5	Amp/Kan/Strep/Sulfa/Tet
	4	1	Tet
Heidelberg	0	0	
	22	3	Kan/Strep/Tet
	11	8	Amox/Amp/Cefox/Cefti/Ceph/ Kan/Strep/Tet
	2	7	Amox/Amp/Cefox/Cefti/ Ceph/Kan/Tet

Except for the first quarter when resistance to three or four antimicrobials was most common, *Salmonella* isolates are most commonly resistant to one or two antimicrobials. Only 17.4 percent of isolates were resistant to more than four antimicrobials. Isolates that were resistant to more than eight antimicrobials were identified in the second and third quarters.



When isolates from all quarters were combined, the most common number of antimicrobials that isolates were resistant to was 1 to 2 followed by 3 to 4. Only 5.1 percent of all isolates were pan-susceptible.



Sampling and Recovery of enteric organisms - Campylobacter

All sites and most pens (94 percent) and samples (74 percent) collected between July 1, 2003, and June 30, 2004, were positive for *Campylobacter.*

Table 10. Number of fecal samples collected and *Campylobacter* prevalence, by *State*

	Sites	Pens	Samples	
State	Number sampled	Number sampled	Number collected	Number tested
IA	12	151	1,043	424
MN	11	151	960	384
NC	12	235	1,260	504
TX	4	50	400	160
Total	39	587	3,663	1,472

Table 11. Number of fecal samples collected and *Campylobacter* prevalence, by type of site

	Sites		Pens		Samples		
Sows present on site	Number sampled	Number positive for Campylobacter	Number sampled	Number (%) positive for Campylobacter	Number collected	Number tested	Number (%) positive for Campylobacter
No	28	28	457	426 (93.2%)	2,560	1,024	764 (74.6%)
Yes	11	11	130	124 (95.4%)	1,103	448	324 (72.3%)
Total	39	39	587	550 (93.7%)	3,663	1,472	1,088 (73.9%)

Table 12. Number of fecal samples collected and *Campylobacter* prevalence, by type of facility

	Sites		Pens		Samples		
Hogs with outdoor access	Number sampled*	Number positive for Campylobacter	Number sampled	Number (%) positive for Campylobacter	Number collected	Number tested	Number (%) positive for Campylobacter
No	28	28	479	453 (94.6%)	2,588	1,042	831 (79.8%)
Yes	10	10	100	89 (89.0%)	1,035	414	246 (59.4%)
Total	38	38	579	542 (93.6%)	3,623	1,456	1,077 (74.0%)

*One site had no annual facility questionnaire.

Antimicrobial resistance—Campylobacter

Similar to *Salmonella,* the highest percentage of *Campylobacter* isolates were resistant to tetracycline. For the purpose of this analysis, isolates that were classified as intermediate were considered susceptible. Resistance among *Campylobacter* isolates is limited for the most part to tetracycline, azithromycin, erythromycin, and clindamycin. No resistance to chloramphenicol was identified.

Table 13. Number and percent of *Campylobacter* isolates resistant to each antibiotic tested

Antibiotic	Number isolates resistant	Percent of isolates resistant (n=1,088)
Tetracycline	776	71.3
Azithromycin	650	59.7
Erythromycin	650	59.7
Clindamycin	463	42.6
Nalidixic Acid	53	4.9
Ciprofloxacin	29	2.7
Gentamicin	2	0.2
Chloramphenicol	0	0.0

Antimicrobial resistance—E. coli

For the purpose of this analysis, isolates that were classified as intermediate were considered susceptible. As with the *Salmonella* isolates, almost all isolates (92.3 percent) are resistant to tetracycline (Table 14). The majority of isolates were not resistant to the remaining antimicrobials. In general, the descending order of resistance of *Salmonella* isolates is similar to the descending order of resistance among *E. coli* isolates. However, the percent of *Salmonella* isolates resistant to a particular antibiotic is higher than *E. coli* isolates in every case except for kanamycin.

Table 14. Number and percent of *E. coli* isolates resistant to each antibiotic tested

Antibiotic	Number isolates resistant	Percent isolates resistant*
Tetracycline	1,231	92.3
Streptomycin	378	28.3
Sulfamethoxazole	364	27.3
Ampicillin	342	25.6
Kanamycin	309	23.2
Choramphenicol	138	10.3
Cephalothin	79	5.9
Trimethoprim/sulfa	47	3.5
Gentamicin	29	2.2
Amoxicillin/clavulanic acid	21	1.6
Cefoxitin	19	1.4
Ceftiofur	14	1.1
Nalidixic acid	5	0.4
Ciprofloxacin	1	0.1
Ceftriaxone	0	0.0

*Total number of isolates was 1,334.